Theory of the Wave Guide of slowly but similarly Varying Section and its Application to the Linear Accelerator

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Abstracts of Papers

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1. Theory of the Wave Guide of slowly but similarly Varying Section and its Application to the Linear Accelerator

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1. When we let the time factor be $e^{j\omega t}$ and choose the appropriate coordinates $(u.\ v,\ z)$ such that the line element is given by

$$ds^2 \doteqdot h_1^2\, du^2 + h_2^2 dv^2 + dz^2 \text{ and } \frac{h_1}{h_2}\ F(u,v), \tag{1}$$

the general modes in the wave are expressed by the following expressions:

$$\left.\begin{array}{lll} E\text{-wave } H_z = O & H_u = \dfrac{j\omega\epsilon'}{h_2}\dfrac{\partial\varphi}{\partial v} f & H_v = -\dfrac{j\omega\epsilon'}{h_1}\dfrac{\partial\varphi}{\partial u} f \\ E_z = \omega_c^2(z)\epsilon'\mu\varphi f & E_u = \dfrac{1}{h_1}\dfrac{\partial\varphi}{\partial u}\dfrac{df}{dz} & E_v = \dfrac{1}{h_2}\dfrac{\partial\varphi}{\partial v}\dfrac{df}{dz} \end{array}\right\}, \tag{2}$$

where $\varphi\ (u,\ v)$ and $f\ (z)$ are determined by

$$\frac{1}{h_1 h_2}\left\{\frac{\partial}{\partial u}\left(\frac{h_2}{h_1}\frac{\partial\varphi}{\partial u}\right) + \frac{\partial}{\partial v}\left(\frac{h_1}{h_2}\frac{\partial\varphi}{\partial v}\right)\right\} + \omega_c^2(z)\epsilon'\mu\varphi = O, \tag{3}$$

$$f(z) = \frac{\text{const}}{\sqrt{\gamma(z)}} \exp\left[\pm\int^z \gamma(z)dz\right], \tag{4}$$

$$\gamma^2(z) + \omega^2\epsilon'\mu \text{ and } \epsilon' \equiv \epsilon - j\sigma/\omega. \tag{5}$$

H–wave can be obtained in the same manner as above.

2. From (2), the general modes in the circular wave guide (as well, in the rectangular wave guide) are written as

$$E_{z_{nm}} = \frac{\text{const}}{a^2(z)\sqrt{\gamma_{nm}(z)}}\ J_n(c_{nm}r)\ \cos n\varphi\ e^{j(\omega t \pm \int^z \gamma_{nm}(z)dz)} etc., \tag{6}$$

where $a(z)$ is the radius of the section.

3. Next, we apply the above theories to a linear accelerator whose wall is given by

$$a(z) = a_0\left[1 + \delta \cos\frac{2\pi z}{L}\right]$$

$a_0\delta$ (the depth of fin) $\ll L$ (the distance between fins). (7)

i) In the case when $\omega \gg c_{01}/a_0\sqrt{\epsilon\mu}$, from (6) the accelerating electric field is exqressed as follows:

$$\left.\begin{array}{l} E_{z01} \doteqdot \text{const}\left\{1 - 2\delta\cos\dfrac{2\pi}{L} z\left[1 + \dfrac{1}{4\beta_{01}^2}\left(\dfrac{C_{01}}{a_0}\right)^2\right]\right\} \displaystyle\sum_{n=-\infty}^{\infty} J_n\left(\frac{\delta}{\beta_{01}}\left[\frac{c_{01}}{a_0}\right]^2 \cdot \frac{L}{2\pi}\right) e^{j(\omega t - \beta z)} \\ \beta_n \equiv \beta_{01} + \dfrac{2\pi}{L} n \qquad \beta_{01} = \sqrt{\omega^2\epsilon\mu - \left(\dfrac{c_{01}}{a_0}\right)^2} \end{array}\right\} \tag{8}$$

The corresponding expression of Slater does not contain any explicit effect of the wall construction on the electron motion.

ii) In the case where $\omega = c_{01}/a_0\sqrt{\epsilon\mu}$, this corresponds to Sloan's ion accelerator, and its accelerating electric field is given by the expression containing elliptic integrals.

4. As the means of adjusting the resonance between the progressing electric waves and the electron beam, we can present the way of changing one of a_0, δ and L with z.

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2. On the Dielectric Measurement in the Centimeter Wave Region

Isao TAKAHASHI, Mikio TAKEYAMA, Hideo SENO and Mitsuo ŌTA

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In the methods of dielectric measurement in the centimeter wave region, so far the graphical solutions or the approximate expessions have been used. In our method the exact explicit expressions of the complex dielectric constant $\epsilon^*/\epsilon_0 = \epsilon'/\epsilon_0 - j\ \epsilon''/\epsilon_0$ have been derived in the theory of wave guide. These general expressions contain Surber's expression of ϵ^* in the shortcircuit-opencircuit method (1948), as a special case and moreover from these equations many expressions can be derived which are convenient for practical measurements. We can also show one of the causes of the errors which attend the shortcircuit-opencircuit method when the mechanical accuracy of the apparatus is not sufficient. Another advantage of our method is that the deformation, for instance the variation of the sample length, can be made unnecessary.

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3. A High Output Demountable Magnetron Oscillator at 2000 Mc/sec

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The researches on the multi-segment magnetron of pulse oscillation which has an output powerful in peak but weak in average have in the past been fully performed to generate oscillation in the decimeter and centimeter wave region. On the other hand the researches on the multi-segment magnetron of continuous oscillation and of high output which is very useful for the dielectric heating, and the study of microwave gas discharge, etc. have not been developed. In order to supplement this deficiency, we have made a trial construction of the high output magnetron of continuous oscillation and easy operation. In our magnetron, the anode is 8 segments of "Tachi-